Profile of an Organization

The Pennsylvania Transportation Institute

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NUERNBERGER/PENN STATE

Pennsylvania Transportation Institute's headquarters at Penn State's University Park campus.

The Pennsylvania Transportation Institute (PTI) was founded at Penn State's University Park Campus in 1968 as part of the university's efforts to respond to a growing demand for transportation research. Originally called the Pennsylvania Transportation and Traffic Safety Center, the organization began with 17 full- and part-time faculty and staff members, 20 graduate students, and research contracts worth $48,000. Today, a quarter of a century later, PTI is one of the nation's leading transportation research institutes, with 105 full- and part-time faculty and staff members, 84 graduate students, and active research contracts worth nearly $20 million.

An interdisciplinary research center, PTI is a component of Penn State's Intercollege Research Programs, a collection of research facilities representing departments and programs throughout the university. PTI faculty research associates, who typically hold joint appointments with the Institute and Penn State's academic colleges, specialize in areas such as architectural, civil, electrical, industrial, and mechanical engineering as well as agriculture, business logistics and management, economics, geography, psychology, and statistics.

Research, Education, and Technology Transfer Activities

Since its inception, PTI has maintained a threefold mission of research, education, and service. In pursuit of this mission, the Institute has aspired to conduct innovative and relevant research directed toward current and future transportation needs, provide significant interdisciplinary educational and research opportunities for undergraduate and graduate students, promote continuing education for transportation professionals, and disseminate research results within and without the transportation field.

The scope of PTI's goals and activities is a direct reflection of the Institute's depth as a research center. PTI's expanding research capabilities cover bus testing and evaluation, computerized forecasting and information systems, road roughness measurement, pavement testing systems, fiscal and administrative studies, vehicle crash tests, and geometric evaluations and studies.

Within the last two fiscal years (1991–1992 and 1992–1993), PTI has increased its number of active research projects from 51 to 95. Research sponsorship by national, state, and local government and private-sector sources—including the U.S. Department of Transportation, the Federal Highway Administration (FHWA), the Federal Transit Administration, the Pennsylvania Department of Transportation (PennDOT), the National Science Foundation, Chrysler Motors Corporation, IBM, the Goodyear Tire and Rubber Company, and numerous small businesses throughout Pennsylvania and other states—has given PTI the opportunity to concentrate on strategic program areas such as Intelligent Vehicle-Highway Systems (IVHS), pavement systems design and characterization, heavy vehicle systems, and civil infrastructure systems renewal.

As a university-based organization, PTI is committed to providing undergraduate and graduate students with quality education and hands-on research opportunities. Access to computer and field facilities, on-site laboratories, and faculty and support staff enables students to obtain real-world research experience and valuable training for future careers in transportation. Full-scale vehicle testing facilities provide PTI student researchers with the means to examine pavement durability, skid resistance, hydroplaning, and other tire/pavement phenomena; vehicle components; the effects of crashes and impacts on barriers and vehicles; bridge construction and design; and escape-ramp performance. PTI's extensive in-house microcomputer system offers complete computer networking capabilities as well as applications ranging from data acquisition and analysis to vehicle simulation, visual and acoustical analysis, and data storage and backup.

In the area of technology transfer, PTI offers continuing education programs to transportation professionals and provides information about advances in transpor-

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PTI students and research associates have access to several on-site microcomputer laboratories.

Research conducted in PTI Pavements and Materials Program has led to new test methods for purchasing and specifying asphalt cement and is helping researchers develop longer-lasting pavements.

tation safety, technology, and knowledge to the community, the state, and the nation.

The PTI-based Local Technical Assistance Program (LTAP) is the only organization in Pennsylvania assigned the sole function of transferring road and bridge technology to the Commonwealth's 2,639 municipalities. Sponsored by PennDOT, FHWA, and Penn State in cooperation with the Pennsylvania Department of Community Affairs, LTAP, which operates under a $2 million contract, is designed to help Pennsylvania's municipalities make the best use of their often-limited maintenance funds. LTAP's staff distributes publications and newsletters on request, and a special team of LTAP engineers travels throughout Pennsylvania offering technical assistance, workshops, and training sessions to municipal employees, usually free of charge to the municipality.

PTI Programs and Centers

PTI's research activities, educational efforts, and service projects are conducted through five core programs: Construction Engineering and Management, Pavements and Materials, Transportation Operations (TOP), Transportation Structures, and Vehicle Systems and Safety, and two major research centers: the Bus Testing and Research Center and the Mid-Atlantic Universities Transportation Center (MAUTC). Each program and center is headed by a faculty director, and each is involved in various industry- and government-sponsored research projects.

Construction Engineering and Management

The goal of PTI's Construction Engineering and Management Program is to gain a better understanding of engineering management practices as they relate to contractor performance.

A recent project by program researchers involved studying the activities of highway maintenance workers and identifying the relevant aspects of employee training and instruction. Using an extensive base of productivity research, including motivational concepts and expectancy theory, the researchers developed a training program (complete with training manual, instructor's guide, and various training aids) designed to motivate and improve the performance of highway maintenance workers. The thrust of the training program is to understand what a maintenance organization needs to be successful and to match those needs with what individuals want from their jobs. City, county, and state highway organizations can use the program as a way to enhance worker performance and achieve cost-effective maintenance of road and highway systems.

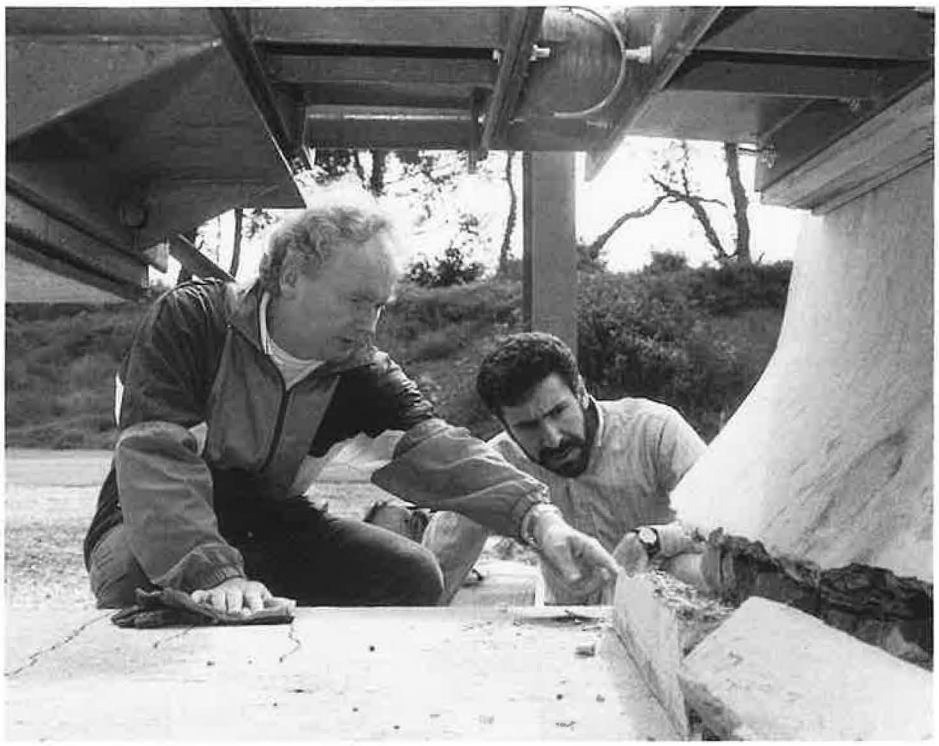
In the area of labor productivity, the program conducted an innovative two-year study to quantify the negative effects of changes and change orders on field construction and operations. With the aid of multivariant statistical models to analyze data from 11 projects representing more than 120 weeks of work, researchers discovered that changes and rework cause, on the average, a 35 percent loss in productivity. The study has broad implications for many different types of construction projects and gives contractors a mathematical indication of the consequences of making late changes in the scope of work.

Pavements and Materials

Research conducted in the Pavements and Materials Program has positioned PTI as one of the top research centers in asphalt-related issues. The program has covered topics ranging from the effects of tire types and pressures on pavement performance to in situ instrumentation for resilient moduli measurements.

A PennDOT-sponsored field study involving PTI's Pavement Durability Research Facility centered on determining the effects of specific material, construction, and traffic variables on the performance of bituminous seal coats. After evaluating a year-old test section on Pennsylvania Route 64 and conducting other tests, researchers discovered that design and construction factors diminished the impact of all other variables in the study. With that information, the researchers made recommendations for improving PennDOT design procedures and quality control methods and also presented PennDOT with a tentative model for predicting seal coat life.

Recently the Pavements and Materials Program and PTI garnered national attention for their work in an extensive four-year study for the Strategic Highway Research Program to characterize the physical proper-



Andrew Scanlon (*left*), Professor of Civil Engineering and Director of PTI's Transportation Structures Program, and graduate student Abbas Aminmansour examine results of impact testing on concrete barrier.

ties of asphalt cement, including rheological and fracture behavior. During the course of the study, researchers established four new systems for testing asphalt: the bending beam rheometer, a patented system designed by researchers at PTI to measure the rheological behavior of asphalt at low temperatures; the dynamic shear rheometer to measure the rheological behavior of asphalt at intermediate and high temperatures; the direct tension test to measure the failure properties of asphalts at low temperatures; and the pressure-aging vessel test, introduced for the first time as a specification test, to predict the long-term performance of asphalt. The new testing procedures have been submitted to ASTM and the American Association of State Highway and Transportation Officials. If approved, the testing procedures will be the new standard testing system for determining future asphalt specifications.

The research also led to the development of a microstructural model that relates the physical and chemical properties of asphalt cement, the discovery of a new hardening phenomenon, a literature data base containing more than 500 abstracts related to asphalt research and pavement performance, and numerous technical papers published in journals and delivered at symposium proceedings.

As a result of the characterization studies, researchers have been able to improve the methods of testing and specifying asphalt cement, thereby moving technology one step closer to creating a better, longer-lasting asphalt concrete pavement for our nation's highways and roads.

Transportation Operations

TOP pursues operations research in highway engineering, highway infrastructure management, public transit, traffic operations, safety and human factors, transportation economics and policy, and transportation planning. In addition to concentrating on IVHS issues and working with PennDOT on developing an Advanced Vehicle Control System (AVCS) to improve safety on rural roadways, TOP recently completed a study of the environmental and economic impacts of adopting low emissions vehicle standards in Pennsylvania. TOP also has assessed pavement design procedures for Pennsylvania and was responsible for organizing a statewide training course for implementing local highway safety programs.

Currently the program is evaluating the effectiveness of pavement markings and delineation for drivers over the age of 65, particularly in regard to nighttime driving. The project's main objective is to identify the information needs of older drivers and to evaluate situations in which driving performances might be improved by enhanced pavement markings and delineation treatments. Researchers are exploring the possibility that such enhancements could significantly increase the mobility of older drivers at night.

TOP also is conducting a National Cooperative Highway Research Program (NCHRP) project titled Expanding the Civil Engineering Pool. The program is designed to identify and develop specific methods that will enhance the supply of civil engineers (in terms of quantity and quality) available to transportation-related agencies. PTI currently is preparing a user's guide that will provide detailed information on how the program's Awareness, Retention, and Curriculum (ARC) model can be implemented in various stages from kindergarten through the university level. The guide offers instructions on how to establish ARC model activities such as career and science fairs, mentoring programs, cooperative education programs, summer internships, and teacher workshops.

Transportation Structures

Although PTI has been involved in structures research for many years, the Transportation Structures Program was not formally established until early 1993. The program focuses on issues related to the design, construction, and maintenance of bridges, transit guideways, and various ancillary transportation structures. One of the program's most recent undertakings is to conduct research on bridge superstructures for PennDOT. The study deals with three specific areas: developing comprehensive design details for converting existing simple-span structures to continuous structures (for live load); establishing specifications for allowable overload stresses on prestressed concrete bridges; and evaluating design and construction methods for integral abutments. Once PTI researchers have completed the project, PennDOT will be able to implement appropriate policies, specifications, and standards for the design, construction, and maintenance of bridge superstructures in Pennsylvania.

Another structures project, a collaborative research effort between PTI and Northwestern University, required a study of the effects of high loading rates on reinforced concrete structures. Using PTI's large-scale impact pendulum facility, researchers performed impact tests on full-scale reinforced concrete beams to determine the various levels of damage that occur as a result of vehicle impact and short-duration loading events. Data from the collaboration were used to develop design recommendations for constructing reinforced concrete structures able to withstand severe impact load conditions.

Vehicle Systems and Safety

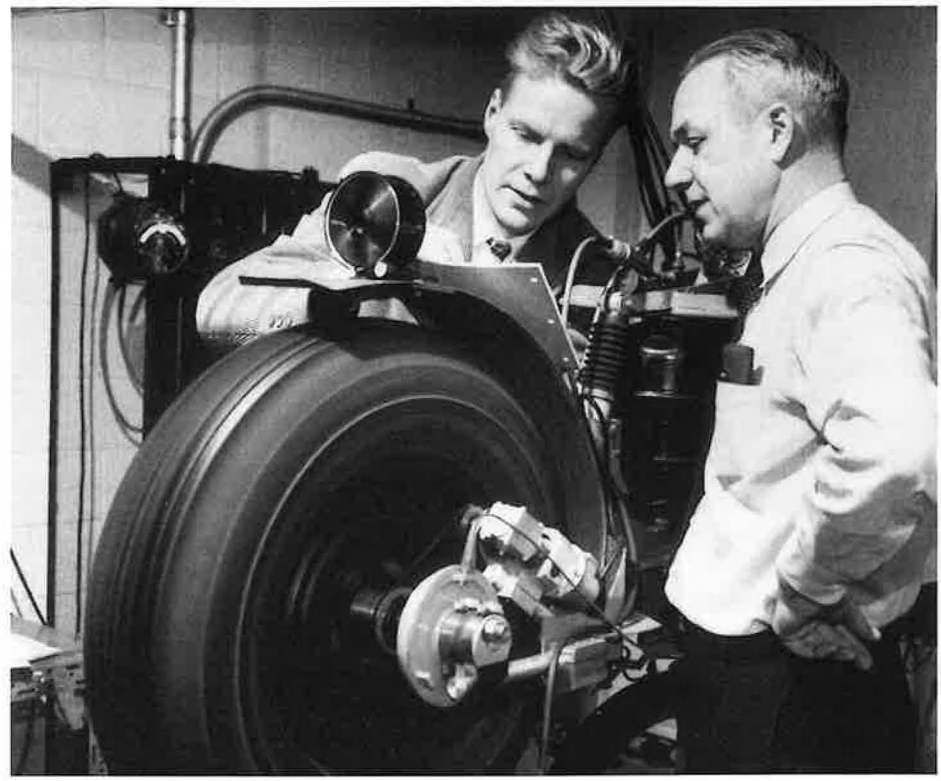
The Vehicle Systems and Safety Program, formerly the Vehicle/Surface Interaction and Safety Program, is involved in numerous research areas, including vehicle modeling and simulation of automobiles, trucks, buses, and trains; vehicle dynamics, safety, and performance; fuel economy and noise testing; crash testing of barriers and vehicles; interaction between vehicles and pavements; transportation safety; and IVHS issues.

Currently the program is addressing rail and bus transit planning and scheduling needs through a project entitled Field Inertial Navigation Device for Intelligent Transit (FIND-IT). PTI, with its Bus Testing and Research Center, is highly qualified, equipped, and prepared to study such transit-related issues. FIND-IT promotes mass transit by reducing transit costs through improved planning, scheduling, and control; increasing ridership by offering timely and reliable user information; and providing flexibility in route planning via tracking traffic flow. The project incorporates IVHS elements such as Advanced Public Transportation Systems (APTS) and Automated Vehicle Location (AVL). Using APTS and AVL, transit systems could offer planning and performance evaluation data, monitoring of service quality, ride-matching information, electronic fare collection, driver quality evaluations, and user information.

The program also is involved in exploring ways of reducing pavement damage caused by tires on heavy trucks. By conducting simultaneous and parallel studies of several experimental systems, researchers have measured and modeled large vehicle dynamic wheel forces on pavements. The project has led to the development of a new data acquisition system that can be used to study vehicle/pavement interactions on low-, medium-, and high-roughness roads for a range of vehicle parameters such as vehicle speed, tire pressure and type, load and load distribution, and suspension type.

As part of an effort to establish better design criteria for truck escape ramps, the program recently completed a study to learn more about the energy-absorbing characteristics of the type of stone used in gravel arrester beds. Through field and laboratory tests, researchers determined the effects of various stones on deceleration rates and were able to develop a method for calculating the optimum strength of various ramps and to create design, construction, and maintenance guidelines.

In 1990, program researchers were funded by the Pennsylvania state police to provide special training seminars to approximately 190 state troopers for the annual inspection of area school buses. The same year researchers also developed a training course and state-of-the-art "skid resistance manual" for state and local highway engineers involved in providing skid-resistant pavements for the nation's roadways.



The late Hartwig W. Kummer (*left*), Research Associate in Mechanical Engineering, and Wolfgang E. Meyer, Professor Emeritus of Mechanical Engineering and one of the founders of PTI, inspect test stand for study of antilock braking systems in 1959. Their subsequent research became the foundation of PTI's Vehicle Systems and Safety Program.

Bus Testing and Research Center

The Altoona Bus Testing and Research Center, the only one of its kind approved for bus testing in the United States, was established in 1989 in response to legislation requiring that all new and modified bus models be thoroughly tested before being purchased with federal funds. The center, part of PTI's Vehicle Systems and Safety Program, is capable of testing up to 8 buses at a time and has already tested more than 40 vehicles. On the first 20 buses alone, staff at the center identified more than 275 failures, resulting in more than 80 probable design changes.

Staff at PTI's Bus Testing and Research Center conduct inspection in one of center's vehicle test bays.

In testing buses for safety, structural integrity, durability, performance, maintainability, noise, and fuel economy, the center not only provides feedback to vehicle manufacturers, it also provides transit authorities with valuable, cost-saving information they can use when making purchase and lease decisions. Procedures and equipment for testing alternative fuels, brakes, and emissions will soon be implemented to meet requirements of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA).

Mid-Atlantic Universities Transportation Center (MAUTC)

MAUTC, which is affiliated with PTI's TOP program, is a consortium of five universities and one of 13 centers in the University Transportation Centers Program (UTCP), a nationwide program established by the U.S. Department of Transportation in 1987. Penn State, as home to PTI, is the lead institution of the five-member consortium (also including the University of Pennsylvania, the University of Virginia, Virginia Polytechnic Institute and State University, and West Virginia University) as well as the national clearinghouse for the UTC program. MAUTC operates on an annual $1 million joint grant from FHWA and FTA that is matched with funds from state, local, university, and private sources. As of this year, the center has established more than 60 research projects focusing on topics such as advanced transit systems, bus transit security, transit management strategies, accident and risk management, congestion alleviation, surface freight transportation technology, and IVHS.

A major goal of MAUTC is to attract the most qualified and best-trained individuals to the study of transportation and transportation-related research. To carry out this goal, the center established the Institute for Advanced Studies in Transportation Engineering and Management (TEaM) at Penn State in 1990. So far, TEaM research initiatives have involved more than 160 students and 13 faculty members at the university. TEaM currently is working with Penn State's civil engineering and business logistics departments to offer students a blended curriculum of transportation engineering, transportation planning, and business management.

In March 1993 MAUTC embarked on a partnership with PennDOT to further strengthen the research, education, and technology transfer components of MAUTC, PennDOT, and PTI. One of the partnership's major efforts has been the development of a Transportation and Civil Engineering Center (TRAC) in Pennsylvania. The primary goal of TRAC, a federally funded outreach program administered by AASHTO, is to increase the number and diversity of students throughout the nation pursuing careers in engineering and transportation-related fields. As part of its activities, TRAC offers summer job opportunities for high school students and provides high school science and mathematics teachers with the materials they need to establish sound transportation- and engineering-related curricula in the classrooms. PTI faculty and staff along with PennDOT engineers will be working with high school teachers and students to develop curricula and student internships at schools in Philadelphia, Pittsburgh, Harrisburg, and other urban areas.

Another PTI project involving the MAUTC/PennDOT partnership is a survey of statewide traffic engineering needs in Pennsylvania. Passage of the Clean Air Act Amendments of 1990 and ISTEA, combined with issues such as IVHS, older drivers, tort liability, and risk management, has changed the character of transportation. In response to these changes, researchers at PTI have devised a strategic plan to examine the traditional traffic engineering function of PennDOT to determine whether currentfunctions are keeping pace with changing conditions and fulfilling required legal mandates and organizational missions.

Looking Ahead

For the future, PTI will continue to participate in collaborative activities with universities in the United States and abroad a s well as with other research units and colleges at Penn State. The Institute is keenly aware that the passage of ISTEA signified a milestone in the transportation industry. ISTEA authorized $151 billion in spending during the subsequent six years, including $660 million for research on IVHS, $240 million for an applied research and technology program, and $108 million for research on long-term pavement performance. PTI has already responded to this important development in several of its program areas (TOP and Vehicle Systems and Safety, for example) and plans to further expand its broad base of research activity by continuing to embark on new research endeavors and explore new technologies. Whatever direction transportation takes in the next century, PTI will remain committed to the active support of undergraduate and graduate students and to the execution of high-quality interdisciplinary research and technology transfer.